R&D for a Km3 Neutrino Detector

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The exploration of the neutrino sky is a of nuclear astrophysics: to date only the sun, one supernova, and the neutrinos generated in the earth's atmosphere have been studied. certainly more to be discovered. For example, the most energetic spots in the universe, Active Galactic Nuclei, are very likely sources of highenergy neutrinos. The discovery of these objects in the neutrino spectrum would open a new window for their study and for the investigation of other cosmological sources as well. detectors currently in operation - AMANDA and BAIKAL - use strings of phototubes arranged in an array, and are the precursors of a future detector with characteristic dimensions of a kilometer. It will enable the measurement of the neutrino spectrum at high energies, a property of the universe that is as fundamental as the cosmic ray spectrum. The collaborations NESTOR (Greece) and ANTARES (France) are two examples of the strong international interest in such a detector, which has acquired the generic name "Km3."

A Km3 able to identify the relatively rare signals of interest and extract the maximum information from them will not be a straightforward scale-up of the existing detectors. Before designing and constructing a Km3, an intensive program of R&D is needed to establish a technical base matched to the scientific goals. An inter-divisional effort at LBNL has been underway and, together with JPL, has produced a key technical advance that, we believe, is ideal for the scientific program of the Km3. Prototype digital optical modules, which incorporate an advanced microchip enabling full wave form reconstruction, have been built and

are undergoing testing here and at the South Pole. Concurrently, a modular computer simulation code is being developed to evaluate detector configurations and performance. Also, we are addressing the challenge of a cost-effective deployment of the photomultiplier tubes in deep ocean water. These activities so far have been supported by Director's Development funds at LBNL and JPL.

It is essential to proceed toward an eventual Km3 in a step-wise manner that can accommodate changes and new developments. Four stages are envisioned:

Stage I: Systems Design, Simulations, and Deployment (one string, 3 years)

Stage II: Demonstration (6 to 12 strings, 2 years, 0.03 km²)

Stage III: Exploratory Science (0.2 km², 3 years)

Stage IV: Full Scope Science (1 km²)

Stage I is the scope of the R&D envisioned here. The R&D activities factor naturally into these areas: electronic systems design, computer simulations, and deployment methodologies. The three R&D efforts are fully coordinated, however, and each effort includes a phased approach in reaching its goals.

Footnotes and References

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